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EXPERIMENT STATION

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BULLETIN LXI

DETERMINATION OF FAT IN MILK

BY C. C. JAMES M.A., PROFESSOR OF CHEMISTRY

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## BULLETIN LXI.

### DETERMINATION OF FAT IN MILK.

#### BABCOCK'S CENTRIFUGAL METHOD.

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Methods have been suggested from time to time for the rapid determination of fat in milk, useful, not simply in the chemical laboratory, but also in the creamery, the cheese-factory and the dairy. Some of these have been modified and improved, most of them rejected as impracticable. Any method suitable to the demands of analysts and dairymen must meet at least four requirements, viz :

1. It must be rapid in its work and in giving results.
2. It must be comparatively easy of manipulation.
3. It must not be very expensive.
4. It must be accurate under varying conditions.

After a thorough test in which the results have been verified by thorough gravimetric analysis, we have concluded that the method devised by Dr. S. M. Babcock, chemist of the Wisconsin Experiment Station, most nearly fulfills the above four requirements. His method was given to the public in Wisconsin bulletin No. 24, 1890, entitled "A new method for the estimation of fat in milk, especially adapted to creameries and cheese-factories."

**METHOD OF ANALYSIS.** Small glass bottles are provided in which the milk is to be tested. These are seven inches high, carrying a graduated neck four inches long and one-quarter inch internal diameter. As the accuracy depends primarily upon the correct graduation of these bottles, they should be purchased only from a reliable firm that guarantee their correctness. Equal volumes (17.5 cubic centimetres) of milk and strong commercial sulphuric acid or oil of vitriol are mixed in these test bottles. The effect is that the casein is dissolved and a rim of yellowish oil begins to form on the dark purple colored solution. The test bottles are then placed in a whirling machine and while kept warm by hot water or steam the centrifugal motion forces the heavy acid to the bottom and the light oil to the top. Warm water is added and the melted oil slowly rises into the neck, the amount read by the graduations giving the percentage of butter fat in the milk. Machines may be obtained that will carry from four to sixty bottles at one time.

I shall now criticise the method under the four requirements before stated.

**1. RAPIDITY.** According to Dr. Babcock's published instructions the milk is measured into the bottles by a glass tube, the acid added measured by a small graduated glass ; then they are whirled for five minutes, warm water added to each bottle, again whirled for one minute, readings taken, bottles emptied and rinsed. The amount of time required depends of course upon the number of analyses made ; one whirling will do for sixty as well as for four, so that the time is principally consumed in measuring the milk and acid and in adding the warm water. After using an apparatus for some time we find that the whole operation for ten samples requires about half an hour. Taking a hint from the practice of the chemist of the Vermont Experiment Station, we have found that in our case the following method has shortened the time required and lightened the labor : 25 cubic centimetres of milk are run into the bottle, then about 3 cubic centimetres of a solution of amyl alcohol and common muriatic acid (equal parts); then the bottle is filled to the neck with strong sulphuric acid from a burette, placed in the machine without any hot water or steam, whirled for one minute, filled with warm water or acid to bring the fat into the graduated neck and the readings at once taken, seven-tenths of which gives the correct percentage of fat in the milk.

**2. EASE OF MANIPULATION.** The instructions are quite simple, and present no great difficulty. The acid must be handled carefully, as it rapidly chars wood and burns clothes and fingers. The sampling must be done carefully and conscientiously. A little natural knack or dexterity in work will greatly assist in the carrying on of the testing, but I can see no reason why a person of ordinary intelligence by carefully following the instructions should not have success in every determination.

**3. COST OR EXPENSE.** The first cost is the principal cost, apart from the time of the person who makes the determinations. If care is exercised no bottles need be broken. Beyond that, the acid is the only material or agent absolutely demanded. This costs from one cent to one-quarter cent per test, according to the quantity of acid procured. If the solution of amyl alcohol and muriatic acid is used, the cost will be slightly increased (about six to ten cents for

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every hundred tests). The first cost of the complete outfit may be gathered from the following three sets of catalogue prices:

Machines made by Cornish, Curtis & Greene, of Fort Atkinson, Wis., for which John S. Pearce & Co., of London, are Ontario agents.

4 bottle test machine.....	\$14 00
10 " " "	20 00
15 " " "	22 00
20 " " "	25 00
30 " " "	29 00

The Beimling machine used by the Vermont Experiment Station, handled by the Creamery Package Manufacturing Co., 20 N. Clark St., Chicago, Ill.

3 bottle test machine.....	\$20 00
6 " " "	25 00
12 " " "	32 00
24 " " "	50 00

Machines made by D. H. Roe & Co., 54 North Clinton St., Chicago, Ill.

4 bottle test machine.....	\$8 00
8 " " "	10 00
12 " " "	14 00
24 " " "	20 00
30 " " "	40 00
60 " " "	50 00

I understand that some other United States dealers are handling machines, but we have not seen their prices. Our Canadian dairy supply companies should be in a position either to manufacture or to handle for this province some of these machines.

**4. ACCURACY OF RESULTS.** The first experimenter made by us was to test the agreement of the bottles with one another. They read as follows on a sample of milk:

Seven bottles gave.....	2.7 per cent. fat.
Three bottles gave.....	2.8 " " "

A gravimetric analysis made in duplicate by the asbestos method gave us for the same milk 2.65 and 2.68 per cent. fat. We have since tested the bottles and also those of the Beimling machine, as follows:

All bottles (C. C. & G. machine .....	3.36 per cent. fat.
Beimling machine .....	3.31 " " "

An advantage of this method is that sour milk can be handled quite easily. We tested a sample of milk fresh and then again after two days standing.

Fresh milk by machine gave.....	3.6 per cent. fat.
Same milk very sour gave.....	3.6 " " "

For the analysis of skim milk and buttermilk, bottles can be obtained that give more delicate readings. We made four com-

parisons on different days with different milks between this rapid method and the gravimetric method (in duplicate) as follows:

(a) Rapid centrifugal.....	2.7	Per cent. fat.
Gravimetric (asbestos method).....	2.67	" "
(b) Rapid centrifugal.....	3.6	" "
Gravimetric (asbestos method).....	3.65	" "
(c) Rapid centrifugal.....	4.3	" "
Gravimetric (asbestos method).....	4.2	" "
(d) Rapid centrifugal.....	3.85	" "
Gravimetric (Adam's paper method)....	3.74	" "

If the bottles are accurately graduated and the instructions are followed, I consider the method exceedingly satisfactory. It is especially useful in experimental work, in chemical laboratories, milk inspection in cities, and in connection with dairies, creameries and cheese factories. It has enabled us to accomplish a larger amount of analytical work than ever before, and is in daily use in our laboratory. Any one desirous of seeing the machines, their method of work, and of judging for themselves as to whether their use is practicable in their work, will be welcome at the chemical and dairy department of this institution. Their use by city health officers and food inspectors, by enterprising breeders of dairy cattle, and in experimental work where every pail of milk is to be analysed is to be strongly commended. With large creameries and cheese factories, the whole question turns on the amount of time required for the work, or the number of analyses to be made each week.

In conclusion I append, as showing the use to which the machine can be put, the average of one week's analyses of milk from six ordinary cows fed for experimental purposes.

Cow.	Average for one week of	
	Morning milk.	Evening milk.
No. 1.....	3.25	3.96
No. 2.....	2.76	4.00
No. 3.....	3.18	4.33
No. 4.....	3.42	4.45
No. 5.....	2.75	4.18
No. 6.....	2.68	3.70

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